



Original communication

Morphological study of the palatal rugae in western Indian population

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ABSTRACT

The aim of this study was to identify and compare the different morphological rugae patterns in males and females of western Indian population, which may be an additional method of identification in cases of crimes or aircraft accidents. A total of 108 plaster casts, equally distributed between the sexes and belonging to similar age-group, were examined for different biometric characteristics of the palatal rugae including number, shape, length, direction and unification and their incidence recorded. Association between these rugae biometric characteristics and sex were tested using chi-square analysis and statistical descriptors were identified for each of these parameters using the SPSS 15.0. The study revealed a statistically significant difference in the total number of rugae between the two sexes ($P = 0.000$). The different types of rugae between the males and females were statistically compared. The female showed a highly significant difference in the sinuous ($P = 0.002$) and primary type ($P = 0.000$) while the male had a significant difference in the unification ($P = 0.005$). The predominant direction of the rugae was found to be forward relative to backward. It may be concluded that the rugae pattern can be an additional method of differentiation between the male and female in conjunction with the other methods such as visual, fingerprints, and dental characteristics in forensic sciences.

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1. Introduction

Transverse palatine folds or palatal rugae (PR), are asymmetrical and irregular elevations of the mucosa located in the anterior third of the palate, made from the lateral membrane of the incisive papilla, arranged in transverse direction from palatine raphe located in the midsagittal plane. These formations have been used in medicolegal identification processes because their individual morphological characteristics are stable over time.¹ Palatine rugae can be used as internal dental-cast reference points for quantification of tooth migration in cases of orthodontic treatment.² For patients who experience difficulty with their speech patterns when acclimating to a new prosthesis, the texture of the rugae in the

palatal region of the denture may prove helpful.³ When traffic accidents, acts of terrorism or mass disasters occur in which it is difficult to identify a person according to fingerprints or dental records, palatine rugae may be an alternative method of identification.⁴ The palatine rugae are permanent and unique to each person and can establish identity through discrimination (via casts, tracings or digitized rugae patterns).^{5,6} The use of teeth in postmortem identification has gained prominence over the last half-century. Postmortem dental identification is, however, not possible in the edentulous and palatal rugae can be used as a supplement in such instances. Thus, palatal rugae appear to possess the features of an ideal forensic identification parameter uniqueness, postmortem resistance and stability. Hence, they can be used in postmortem identification provided an antemortem record exists. Most of the previous studies have focused on the use of palatal rugae for personal identification, with only few limited studies on sexual dimorphism in the biometric features of the palatal rugae. The present study, thus, has ventured (1) to determine prevalence of the palatal rugae in a group of western Indian

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population, (2) to describe the different biometric characteristics of the palatal rugae, and (3) to determine the common patterns of palatal rugae in males and females in this group of population.

2. Materials and method

The present study was carried out in the Department of Oral Diagnosis, Medicine & Radiology and Department of Orthodontia, K.M. Shah Dental College & Hospital, Sumandeep Vidyapeeth University, Piparia, Vadodara after obtaining institutional ethical committee approval. The material for this study consisted of dental casts of patients of Gujarat state of Western India housed in the Department of Orthodontia. A total of 108 dental casts, fully maxillary toothed, without considering the third molar were selected for the study including 54 of males and 54 of females. Considering the lack of consensus on rugae stability with respect to aging,^{7–9} the study casts were derived of the individuals within a narrow age-range (16–22 years). All plaster casts were obtained following informed verbal consent. The casts were free of voids and air bubbles. The dental casts exhibiting severe malocclusion and/or palatal asymmetries were excluded from this study. The rugae were delineated using a sharp graphite pencil under adequate light and magnification. Subsequently, the information obtained was recorded in a rugoscopy record or rugograma, including: shape, number, length, direction and unification of the palatal rugae and using the SPSS 15.0 statistical descriptors were identified for each of these parameters. The level of statistical significance is at $P < 0.05$.

2.1. Shape analysis

The shape of the palatine rugae was registered according to the classification of Trobo (Pueyo et al., 1994).¹⁰ This classification divides rugae into two groups: Simple rugae, classified as ABCDEF, where rugae shapes are well defined, and Composed rugae, classified as type X, with a polymorphisms variety (these rugae composed result of the union of two or more simple rugae).

2.2. Number analysis

There were all palatal rugae that were totally bounded in calcorrugoscopy.

2.3. Length analysis

Rugae are measured in a straight line between the origin and termination and are grouped into three categories:

1. primary: 5 mm or more;
2. secondary: 3–5 mm;
3. fragmentary: 2–3 mm.

Rugae smaller than 2 mm are disregarded.

2.4. Direction analysis

The direction of each primary rugae was determined by measuring the angle between the line joining its origin and termination and a line perpendicular to the median raphe. Forward-directed rugae were associated with positive angles, backward-directed rugae with negative angles, and perpendicular rugae with angles of zero degrees. Unification occurs when two rugae are joined at their origin or termination. Unifications in which two rugae began from the same origin but immediately diverged were classified as diverging. Rugae with different origins which joined on their lateral portions were classified as converging.

3. Results

The total number of rugae in males and females is illustrated in Table 1. The detailed distributions of different types of rugae as well as the descriptive statistics are shown in Table 2. There was a highly significant difference in the sinuous type of rugae which was found to be higher among females than males ($P = 0.002$). A statistically significant difference in primary type was noticed which was higher in females than males ($P = 0.000$). Unification was found significantly higher in males compared to females ($P = 0.005$). The predominant direction of the rugae was found to be forward (87) relative to backward direction (27). The most prevalent shape of palatal rugae was the sinuous (71%), followed by the wavy (19%), curve (6.66%), point (1.5%) and circular (1.2%). There were only 2 angled rugae and no composed rugae on the sample type analyzed. The details of the distribution of the rugae shape by sex are detailed in Table 2. The total number of palatal rugae accounted in the total sample was 900, this value being slightly higher in the palates of women (498) than men (402), with a significant difference ($P = 0.000$). The details of these values are mentioned in Table 2.

4. Discussion

The palatal rugae like fingerprints do not change during the life of the individual, are protected from trauma and high temperatures for its internal position in the oral cavity, surrounded and protected by lips, cheeks, tongue, teeth and bone. Once formed, only changed in its length, due to normal growth, these rugae stay in the same position throughout the life of a person. Even disease, trauma or chemical attack seem able to change the shape of the palatal rugae.¹¹ There are different ways to analyze the palatal rugae. Intraoral inspection is probably the most used and most easy and economical method. However, this can create difficulties if a future comparative review is required. A more detailed and accurate, and the need to preserve evidence may justify the use of photographs or impressions.¹² While observing the shape of the rugae is a subjective process, it is relatively easy to record and does not require complex instrumentation. The palatoscopy is a technique that can be of great interest in human identification. In fact, contrary to the lips that are printed, it is possible to obtain antemortem data stable over time, such records that are in dental practice in its various forms (dental casts, intraoral photographs and dental prostheses).

Table 1

Chi-square analysis for assessing sex differentiation by using total no of rugae, type, shape, pattern, direction and unification.

Sr. No.	Characteristics	Total $n = 108$	Male $N = 54$ (50%)	Female $N = 54$ (50%)	P-value
1	Total no. of rugae	900	402 (44.66%)	498 (55.33%)	.000
2	Primary	665	297 (44.66%)	368 (55.33%)	.000
3	Secondary	218	98 (44.95%)	120 (55.04%)	.633
4	Fragmented	17	7 (41.17%)	10 (58.82%)	.792
5	Point	14	6 (42.85%)	8 (57.14%)	.802
6	Wavy	177	83 (46.89%)	94 (53.10%)	.679
7	Curved	60	29 (48.33%)	31 (51.66%)	.978
8	Angled	2	0	2 (100.00%)	.153
9	Sinuous	639	282 (44.13%)	357 (55.86%)	.002
10	Circular	11	4 (36.36%)	7 (63.63%)	.502
11	Composed	00	00	00	–
12	Predominant direction				
	Forward	87	41 (47.12%)	46 (52.87%)	.224
	Backward	21	13 (61.90%)	08 (38.09%)	
13	Unification				
	1	34	21 (61.76%)	13 (38.23%)	.005
	2	05	05 (100.00%)	00	
	3	05	04 (80.00%)	01 (20.00%)	
	Absent	64	24 (37.50%)	40 (62.50%)	

Table 2
Details of distribution of types of rugae in males and females.

Sr. No.	Characteristics	Male N = 54 (50%)		Female N = 54 (50%)		Total n = 108	
		Absent	Present	Absent	Present	Absent	Present
1	Primary	0	54 (100.0%)	2 (3.70%)	52 (96.29%)	02 (1.85%)	106 (98.14%)
2	Secondary	07 (12.96%)	47 (87.03%)	05 (9.25%)	49 (90.74%)	12 (11.11%)	96 (88.88%)
3	Fragmented	48 (88.88%)	06 (11.11%)	46 (85.18%)	08 (14.81%)	94 (87.03%)	14 (12.96%)
4	Point	49	05	47 (87.03%)	07 (12.96%)	96 (88.88%)	12 (11.11%)
5	Wavy	14 (25.92%)	40 (74.07%)	07 (12.96%)	47 (87.03%)	21 (19.44%)	87 (80.55%)
6	Curved	33 (61.11%)	21 (38.88%)	31 (57.40%)	23 (42.59%)	64 (59.25%)	44 (40.74%)
7	Angled	54 (100 %)	00	52 (96.29%)	02 (3.70%)	106 (98.14%)	02 (1.85%)
8	Sinuuous	00	54	00	54	00	108
9	Circular	51 (94.44%)	03 (5.55%)	48 (88.88%)	06 (11.11%)	99 (91.66%)	09 (8.33%)
10	Composed	00	00	00	00	00	00
11	Predominant direction						
	Forward	13 (24.07%)	41 (75.92%)	08 (14.81%)	46 (85.18%)	21 (19.44%)	87 (80.55%)
	Backward	41 (75.92%)	13 (24.07%)	46 (85.18%)	08 (14.81%)	87 (80.55%)	21 (19.44%)
12	Unification	24 (44.44%)	30 (55.55%)	40 (74.07%)	14 (25.92%)	64 (59.25%)	44 (4.74%)

However, palatoscopy might not be as useful in investigations of crime scenes and in linking suspects to crime scenes because such tests are not expected to find in such circumstances. It is important to note the existence of abnormal patterns and shapes on palatal rugae, these anomalies are considered as a reflection of alterations in the normal growth.

In the present study, the most commonly noticed palatal rugae were the sinuous and wavy, representing almost 90% of the total population, which is in agreement with the previous studies.^{8,13} Very few studies suggested the presence of sexual dimorphism in the biometric features of the palatal rugae.¹⁴ The present study also reported some of the morphological differences related to the sex of an individual. The present study showed a highly significant difference in the sinuous ($P = 0.002$) and primary ($P = 0.000$) type of rugae which was found to be higher among females than males. In contrast, unification was found significantly higher in males compared to females ($P = 0.005$). The predominant direction of the rugae was found to be forward relative to backward direction. The rugae having forward direction was noticed to be slightly more in females, whereas the rugae with backward direction were reported more in males relative to females, with statistically non-significant differences. In this study, the total number of rugae was found to be significantly higher in females compared to males ($P = 0.000$). The results of this study do not conform to the results presented by Dohke and Osato¹⁵ who indicated that among the Japanese, the females had fewer rugae than males. This finding may indicate that there is some racial and sex differences. However, those two-three differences which we have reported in this study including number and the morphological patterns of the palatal rugae could be factors for identification together with other methods of identification.

In the limited literature, a lack of uniformity in nomenclature is clear, making it more difficult to compare the results. As the majority of methods developed individually, and not validity information reported, with low reproducibility, and due to the importance of describing the rugoscopy characteristics in dental-forensic expertise, we suggest developing a standard method for evaluation of palatal rugae, as described in this study.

5. Conclusion

Located in the anterior half of the roof of the mouth, the palatine rugae have much to offer the dental profession. Palatal rugae pattern is considered to be unique to an individual and their use in forensic identification has been advocated and applied. Moreover,

the results of several studies show a significant association between rugae forms and ethnicity. In this study, the morphological characteristics of the palatal rugae have been studied in western Indian population. Statistically significant differences between the males and females were observed in number, shape and unification of the rugae. The interpretations derived from this study are precluded by limited sample size which definitely invites the more extensive and detailed study in more logical manner with emphasis for larger or elaborate sample size to further validate our findings.

Conflict of interest

None declared.

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Ethical approval

None declared.

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